



# Radiation Safety



## RADIATION PROCEDURES MANUAL

### Procedure Cover Sheet

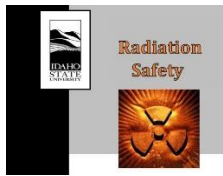
Procedure Title: 100 mrem Report

Procedure Number: RS-13 rev0

Effective Date: 1/15/2021

Reviewed By: Mason Jaussi Date: 04-JAN-2021  
Assistant Radiation Safety Officer

Approved By: John Longley Date: 07-JAN-2021  
Radiation Safety Officer

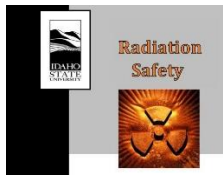


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## 1. INTRODUCTION

The licensee is required by 10 CFR 20.1301 to conduct operations such that the total effective dose equivalent (TEDE) to an individual member of the public does not exceed 0.1 rem (100 mrem) in a year from licensed operations. 10 CFR 20.1101 (a-d) requires the licensee to develop, document, and implement procedures, engineering controls, and constraints to keep occupational doses, doses to members of the public, and doses to the environment as low as reasonably achievable (ALARA) from licensed activities.

Furthermore, the licensee shall put a constraint on air emissions of radioactive material to the environment (excluding Radon-222 and its daughters) such that the individual member of the public likely to receive the highest dose will not be expected to receive a total effective dose equivalent (TEDE) in excess of 10 mrem per year from these emissions. The 100 mrem report is prepared in the first quarter of each calendar year after full year dosimetry results are available and demonstrates ISU complies with the dose limits for members of the public.

## 2. PURPOSE

The purpose of this procedure is to provide instructions for compiling the annual 100 mrem Report to demonstrate compliance with the requirements of 10 CFR 20.1101 and 10 CFR 20.1301.

## 3. SCOPE

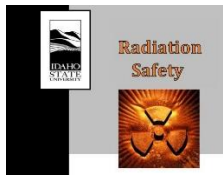
This procedure outlines the steps to compile the annual area and environmental dosimeter results and model the hypothetical annual air emissions from ISU licensed facilities into the 100 mrem Report.

## 4. ROLES AND RESPONSIBILITIES

- **Radiation Safety Officer** - Review and approve the annual 100 mrem report.
- **Radiation Safety Staff** - Compile the annual 100 mrem report in accordance with this procedure.

## 4. REQUIRED MATERIAL(S)

- 100 mrem Report Template
- Area Dosimeter Annual Data
- 100 mrem Report Workbook
- Annual AGN-201 Full Power Survey
- RAM Inventory report for ISU facilities
- COMPLY code



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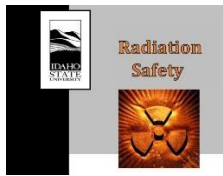
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## 6. PROCEDURE

### 6.1. Report Preparation

The 100 mrem report is written for the previous calendar year at the beginning of each year when all quarterly dose reports have been received from the dosimetry vendor.

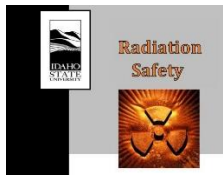
- 6.1.1. Access the 100 mrem Report Template
- 6.1.2. On the Cover page, replace the [YEAR] with the previous calendar year and enter your [NAME] and [DATE].
- 6.1.3. Search the document (Ctrl+H) for any mentions of [YEAR] and replace with the previous calendar year.
- 6.1.4. Download and compile the annual area and environmental monitor results from Landauer
  - 6.1.4.1. Access the Landauer database
  - 6.1.4.2. Select – Dose History – Search Dose History and enter the following criteria into the Filer Search Boxes and press Search
    - Begin Wear Date: [Year]/01/01
    - End Wear Date: [Year]/12/31
    - Account = 189742
    - Subaccount = Area Monitors
    - Status = Active Only
  - 6.1.4.3. Export the **Dosimeter Doses** (Not the Participant Doses) to Excel.
  - 6.1.4.4. Repeat steps 6.1.4.2 and 6.1.4.3, for the Environmental Subaccount.
- 6.1.5. Compile Dosimeter Results
  - 6.1.5.1. Open the excel workbooks with the exported results and copy and paste the Area Monitor and Environmental results into the 100 mrem Report Workbook. Ensure the results are aligned with the proper column headers.
  - 6.1.5.2. Name this worksheet tab: Master
  - 6.1.5.3. Create a copy of the Master tab and name it: Working
  - 6.1.5.4. Save the compiled workbook as: YEAR\_Monitoring Results
  - 6.1.5.5. Clean up the **Working tab** for better data access and visibility by performing the following:



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- Delete all the worksheet columns **except for:** Participant Name, Subaccount Code, Begin Wear Date, End Wear Date, Total DDE, Total LDE, Total SDE, Total Neutron, Fast Neutron, Thermal Neutron, and Frequency.
  - Select the Total DDE, Total LDE, Total SDE, Total Neutron, Fast Neutron, Thermal Neutron columns and results, Press (Ctrl+H) and enter the following:
    - Press Ctrl+H
    - Find What: SL
    - Replace With: 0
    - Select Replace All
  - Repeat the above step but leave the “Find What:” blank. This will replace all blanks in the selected columns with ‘0’.
  - Select the first monitoring result that has a green flag in the top left corner of the cell, highlight monitoring results and click the error box and select – covert to number.
- 6.1.5.6. Select the entire data table (including the headers) – Insert – Pivot Table – New Worksheet
- 6.1.5.7. Format the Pivot Table to show the quarterly dosimeter results by sub-account: Deep Dose Equivalent (DDE), Fast Neutron, and Thermal Neutron, for each monitor.
- 6.1.5.8. Copy the pivot table results for each sub-account into their respective locations on the Table in the tab labeled Tables1&2.
- 6.1.6. Table Quality Control Check
- 6.1.6.1. Check the area monitor data to ensure it was copied correctly.
  - 6.1.6.2. Check the formula in the columns labeled Total (P, Th, FN) is taking a sum of the photon (P), thermal neutron (Th), and fast neutron (FN) results for each quarter.
  - 6.1.6.3. Check the formula in the column labeled N+DDE is taking a sum of the Total (P, Th, FN) results for each monitor.



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- 6.1.6.4. Check the formula in the column labeled (N+DDE/hour) is dividing the result in the N+DDE column by the constant 8,766 (which is the total number of hours per year).
- 6.1.6.5. Check that the column labeled 'T' (occupancy factors) have the appropriate occupancy value for each monitored location. Compare with the values in the Occupancy Table Tab in the 100 mrem Report Workbook. See Appendix I for a discussion of the calculation of occupancy factors.
- 6.1.6.6. Check the formula in the column labeled Dose is multiplying the value in the (N+DDE/hour) column by the occupancy factor (column labeled 'T').

## 6.2. Annual Area Monitoring Section

This section provides the steps to create and add Table 1 and 2 to the 100 mrem Report. Table 1 shows the quarterly dose equivalent results for all ISU area monitors without correcting for occupancy. Table 2 shows the annual dose equivalent for each area monitor corrected for occupancy.

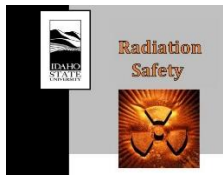
**Note:** If there are Monthly dosimeters an additional table is created to show the monthly monitoring results.

### 6.2.1. Generate Table 1 – Quarterly dose equivalent for ISU area monitor locations

- 6.2.1.1. Access the 100 mrem Report Workbook, Tables1&2 tab, and copy the table excluding the following columns: N+DDE, (N+DDE/hour), T, and Dose.
- 6.2.1.2. Paste the table into the ISU 100 mrem Report, section Annual Area Monitoring, below the figure labeled, Table 1. Quarterly dose equivalent (mrem) for ISU area monitor locations.
- 6.2.1.3. Ensure the Table is aligned with the page and all data was copied correctly.

### 6.2.2. Generate Table 2 – Annual dose equivalent for ISU area monitor locations corrected for occupancy

- 6.2.2.1. Access the 100 mrem Report Workbook, Tables1&2 tab, hide the quarterly result columns, and copy only the following table columns: Series, Area Monitor Location, Total (P, Th, FN), N+DDE, (N+DDE/hour), T, and Dose.
- 6.2.2.2. Paste the table into the ISU 100 mrem Report, section Annual Area Monitoring, below the figure labeled, Table 2. Annual dose equivalent (mrem) for ISU area monitors corrected for area occupancy.
- 6.2.2.3. Ensure the Table is aligned with the page and all data was copied correctly.



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### 6.3. Annual Air Emissions Section

The purpose of this section is to model a hypothetical release of ISU's source inventory available for dispersion into the environment. A source term is generated for each ISU operated facility that stores and/or works with a meaningful quantity of radioactive material. The release is modeled using the EPA COMPLY software. The following sections address the menus within the input parameters used to model the release.

#### 6.3.1. Facility Source Terms

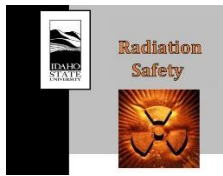
6.3.1.1. A query of the HPAssist database is performed for any ISU facilities that use or store appreciable quantities of radioactive material. The query is to include all radioactive materials processed and stored during the calendar year. The data should be compiled in the 100 mrem Report Workbook in a worksheet for each facility. Truncate the facility source term inventory to  $1 \times 10^{-12}$  Ci. The source term will be developed in accordance with guidance from EPA-520/1-89-002 and will be documented and included as an attachment to the 100 mrem report. Provide a discussion of all assumptions and methodology used to develop each facility's source term in Section 4.2 of the 100 mrem Report. As an example, see the assumptions and methodology used to develop each facility's source term in the previous year's 100 mrem Report.

**Note:** At the time of writing rev.0 of this procedure, the following facilities are included in the report: RAM Waste Storage, Physical Sciences, Engineering, Idaho Accelerator Center, Eames Complex, and CAES. If a facility is added or removed, the 100 mrem Report, Section 4.2.2 and 4.3, Table 3 must be updated to reflect the change.

#### 6.3.2. Modeling Air Emissions in COMPLY

6.3.2.1. Access the COMPLY program and enter the following:

- **Title:** Compliance
- **Company:** Idaho State University
- **Facility name:** [Enter Facility Name]
- **Address:** [Enter Facility Address]
- **Contact Name:** [Your Name]
- **Phone Number:** [Radiation Safety Office #]
- **File name:** [Year\_Facility.LIS]



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6.3.2.2. The COMPLY program will ask a series of questions

- Do you have multiple stacks (multiple release points): ‘N’ (No)
- Do you want to input NUCLIDES from a FILE or from the KEYBOARD: **Keyboard**
  - Enter the nuclides that comprise the facility’s source term. Ex. CS-137. Hit ENTER and input the remaining nuclides. When finished, hit ENTER twice.
  - You will be given the chance to review the nuclides that were entered and the associated inhalation classes. If all nuclide names and classes are correct enter ‘Y’. If they are not correct, enter ‘N’ and follow the prompt steps to correct the error.
- Do you want to save the NUCLIDES in a File: ‘Y’
  - Save and name the NUCLIDES file in the following format: [Year\_Facility\_ST.DAT]
- A prompt will appear and ask if you want to use Compliance Level 1, enter ‘N’ and type ‘3’.
  - This tells the program that you want the facility to be evaluated at a Compliance Level 3. A description of the Compliance Level 3 can be found in the COMPLY User Manual.
- Specify the RELEASE RATE units: ‘Y’
  - ‘Y’ indicates a release rate of curies/year

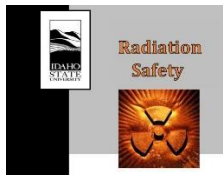
6.3.2.3. Next, you will be prompted to enter the release rate [Ci/yr] for each of the nuclides in the facility’s source term. Once a release rate has been entered for each of the nuclides, you will be able to review the facility source term and release rates. If all release rates are OK, type ‘Y’. If there is an error, type ‘N’ and follow the prompt to correct the error.

6.3.2.4. Enter the facilities RELEASE HEIGHT in meters.

- See Appendix II for the facility release heights. If a facility is not listed, determine the facilities release height.

6.3.2.5. Enter the BUILDING (facility) HEIGHT in meters.





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- See Appendix II for the facility heights. If a facility is not listed, determine the facility's height.

6.3.2.6. Are the source and the receptor in the SAME building: 'N'

- This answer will typically be NO, the receptor is not in the same building. IF the receptor is in the same building type 'Y'.

6.3.2.7. Enter the DISTANCE (meters) from the SOURCE to the RECEPTOR.

- See Appendix II for the receptor distance for each facility. If a facility is not listed, determine the nearest receptor and calculate the distance in meters.

6.3.2.8. Enter the facility (building) WIDTH in meters.

- See Appendix II for the facility widths. If a facility is not listed, determine facility width in meters.

6.3.2.9. The default wind speed is 2.0 m/sec, do you want to use the default value: 'Y'

6.3.2.10. Please type in the distance from the source to the farm producing vegetables (meters, or "H" if at Home): 'H'

6.3.2.11. Please type in the distance from the source to the farm producing milk and meat (meters, or "H" if at Home): 'H'

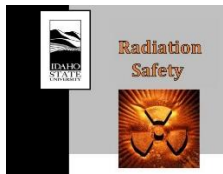
### 6.3.3. COMPLY Results

6.3.3.1. The result will be displayed as the Effective dose equivalent (mrem/yr) and a prompt indicating that the facility either PASSED or FAILED at compliance level 3. Press ENTER to proceed.

6.3.3.2. Do you want to go to a higher level:

- If PASSED type 'N'
- If FAILED type 'Y' and follow the prompts to adjust the meteorological, receptor garden distance, and receptor meat production distance to a more realistic value, rather than the conservative value of food production at the receptors home (if possible).

Once the program has ended, repeat steps 6.3.2 through 6.3.3.2 for each facility.



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## 6.4. Results

- 6.4.1. Compile the COMPLY report results and enter the EDE for each facility into the 100 mrem Report Section 4.3, Table 3.
- 6.4.2. Access each facility COMPLY report, saved as [Year\_Facility.LIS], open in Notepad, and copy and paste the facility compliance report into the 100 mrem Report Appendix B.
  - Adjust the COMPLY report formatting to improve readability. This will include removing blank spaces to condense each report down to a minimum number of pages for each facility.
- 6.4.3. Attach the annual AGN-201 Full Power Survey to Appendix A of the 100 mrem Report.

## 6.5. Conclusions

This section of the 100 mrem report will address any occupancy adjusted dosimeter results that exceed 100 mrem and any modeled air emissions exceeding 10 mrem. Include a description of the area monitor location, an explanation of the result, and if the area is restricted or unrestricted to the general public.

## 6.6. Report QC

Thoroughly review each section of the 100 mrem Report to ensure all sections are complete and all data is entered correctly.

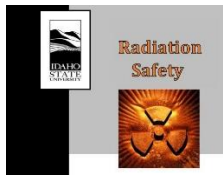
## 7. REFERENCES

10 CFR Part 20, Standards for protection against radiation.

Environmental Protection Agency. A guide for determining compliance with the clean air act standards for radionuclide emissions from NRC-licensed and non-DOE federal facilities. Revision 2; EPA-520/1-89-002.

Nuclear Regulatory Commission. Consolidated guidance about materials licenses: program-specific guidance about licenses of broad scope. NUREG-1556, Volume 11, rev. 1.

Nuclear Regulatory Commission. Constraint on releases of airborne radioactive materials to the environment for licensees other than power reactors. Regulatory Guide 4.20, rev. 1.

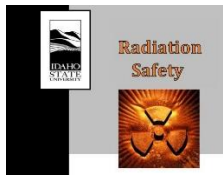


## Appendix I – Occupancy Factors

NUREG-1556 vol.11, Appendix J allows the licensee to calculate occupancy classifications based on the likely fraction of time an individual may be present in the area. Occupancy factors were determined in accordance with this provision by observation of traffic patterns and knowledge of the general use of the area being monitored. The numerical values were based on the occupancy classifications of NCRP-147, Structural Shielding Design for Medical X-ray Imaging Facilities as follows:

- The factor of 2,000 was used for full occupancy.
- The factor of 1,000 was used for part time occupancy.
- The occupancy for classrooms is based on an individual having class in the room two hours a day five days a week 50 weeks per year.
- The remaining occupancy factors are obtained by multiplying 2,000 hours/year by the fractions listed in NCRP-147 Table 4.1. These occupancy factors have been calculated and are shown in the table below.
- When occupancy was uncertain, 2,000 hours was assumed to yield a conservative dose estimate

|  |              |                 |
|--|--------------|-----------------|
| General work area, full-time occupancy | 8 hours/day  | 2000 hours/year |
| General work area, part-time occupancy | 4 hours/day  | 1000 hours/year |
| Classroom                              | 2 hours/day  | 500 hours/year  |
| Corridors/labs                         | 8 hours/week | 400 hours/year  |
| Doorways                               | 5 hours/week | 250 hours/year  |
| Toilets/storage rooms                  | 2 hours/week | 100 hours/year  |
| Outdoor/parking lots                   | 1 hour/week  | 50 hours/year   |



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## Appendix II – COMPLY Parameters

### Facility Parameters:

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| <b>Facility</b> | <b>Release Height<br/>[m]</b> | <b>Building Height<br/>[m]</b> | <b>Building<br/>Width [m]</b> | <b>Receptor<br/>Distance [m]</b> | <b>Receptor</b> |
|-----------------|-------------------------------|--------------------------------|-------------------------------|----------------------------------|-----------------|
| <b>IAC</b>      | 9                             | 6                              | 20                            | 146                              | Residence       |
| <b>Physics</b>  | 12                            | 10                             | 30                            | 40                               | Residence       |
| <b>LEL</b>      | 12                            | 10                             | 20                            | 60                               | Church          |
| <b>RWS</b>      | 7                             | 5                              | 8                             | 40                               | Office          |
| <b>EAMES</b>    | 9                             | 8                              | 100                           | 207                              | Office          |
| <b>CAES</b>     | 9                             | 6                              | 100                           | 100                              | Office          |

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